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ABSTRACT

Possibilities of conceptual and pragmatic analysis exist for identifying epistemological processing in teacher thinking. These modes of organizing thought condition classroom planning, shape meaning from a virtual didactic knowledge-store, and scaffold further pedagogical interactions. The semio-cognitive grammar proposed is adapted to the analysis of teachers' verbalizations. The purpose of this metasemantic and pragmatic grammar is to analyze the procedures of didactic embedding. This grammar can prove to be useful in the analysis of didactic transposition in other subject matters. This model might lead to pedagogical applications and help bring about some understanding of expert ways of didactic improvising in a pedagogical context thus inducing a new metacognitive and pragmatic instructional design. Includes a list of 51 references. (JD)

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# Towards a Pragmatic Grammar of Teachers' Epistemic Networks*

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## ABSTRACT

Methods used to be of cognitive processing can be useful in describing epistemological work of didactic processing, that is metanetworks related to the ways of knowing. Organizing knowledge for transmission involves a transposition of the curriculum by teachers from theory to practice. Such knowledge can be analyzed in terms of hierarchy and linearization. The corpus studied in this research is comprised of interviews of 30 experts who teach Language Arts at the high school level in Geneva, Switzerland. The purpose of this article will be to demonstrate the use by these experienced teachers of a conceptual grammar which focuses on didactic metaframing.

This article considers the possible merging of complementary conceptual frameworks, and indicates their compatibility: 1) the frame of "expertise" in the paradigm of teacher thinking, 2) the theory of representation in cognitive sciences and its use in semantic grammar, and 3) the pragmatics of intentionality (Searle, 1983; Fauconnier, 1988).

## INTRODUCTION

The paradigm of teacher thinking has freed itself from the procedures of the process-product paradigm (Clark, 1989). While researchers of the process-product paradigm are attempting to set up didactic models based on a correlational procedure, from constants of effective behaviors of teachers, ethno-methodological and cognitive research on teacher thinking is based on a concept of expertise which is more contextualized in terms of the epistemologies characteristic of each subject matter. In order to establish practical policies for teacher training, it is possible to question teachers about their practices in the classroom and to gather information from verbatim protocols of their answers. Gage (1989) has argued that there is no incompatibility between process-product modeling and ethno-methodological modeling since these two paradigms pursue goals, which are different, yet probably complementary. In a similar vein, this article shall focus on the complementary nature of sharp, cognitive psychology methods and large context encompassing methods centered on teachers' cognitions. Comparing the above two paradigms would probably make it possible to identify them as distinct levels in a model based on the compatibility of their approaches. For example, cognitive research on learning could be considered as centered on frames, because it aims at determining procedures of semantic framing in comprehension or in production, regardless of their context, whereas ethno-methodological and cognitive research on teaching, interested in large units of contextualized meaning, would deal with metaframes. It is interesting to note that, in cognitive psychology, frames can be defined regardless of how they are embedded in other frames, metaframes or designs, despite the fact that this embedding occurs in everyday contexts. For example, an instructional sequence can be reported in a discourse situation under a narrative form. There are frames which affect other frames and their complex function still needs to be clarified. Didactic discourse is, strictly speaking, an embedding of several frames so that they may be exposed and transmitted. This explains the pertinence of qualitative

metaframe analyses which focus on the exposition of large thematic units.

Currently, many attempts are being made to link research on teaching with research on learning. In action research the expert teacher is considered as a teacher-learner in the continuous process of restructuring meaning (Clark, 1986; Berliner, 1989). The learner in this case is in fact a person who is self-taught. The links between these two types of research were brought up during discussions following several presentations given at the AERA's 1989 convention in San Fransisco (Yinger, 1989; Rohrkemper, 1989; etc.). They have also been proposed as a topic for the convention of the International Study Association on Teacher Thinking in 1990: "Relationships between paradigms used in cognitive psychology to study thinking and those used in research on teacher thinking." Furthermore, research on learning is closely related to metaframes analysis through studies on induction and inference (Holland, Holyoak, Nisbett & Thagard, 1986; Thagard, 1988). In a similar attempt to bring these methodologies closer together, I developed a conceptual grammar adapted to the analysis of teachers' thinking. My research makes use of procedures belonging to frames analysis in order to shed light on the metaframing of didactic discourse.

It would be partly incorrect to speak about the topic of expert frames by first looking at teacher thinking since this body of research results chronologically from research in the cognitive sciences. Furthermore, some important analyses of teaching expertise were done in collaboration with cogniticians. The transfer of the methods of cognitive analysis to teacher thinking research was carried out mainly in terms of routines. The latter represent sequences of actions which include schemas that cluster information (Yinger, 1977; Leinhardt, Weidman & Hammond, 1984). In order to adapt cognitive research to actual teaching situations, Leinhardt developed the concept of agenda (1983). Experts would have a double internal agenda, a modular set of segmented topic levels which would be finalized in terms of content and strategies of interaction.

Cognitive framing seems to follow a set of rules, some aspects of which are described by Leinhardt, Weidman & Hammond (1984) as algorithms or networks of embedded planning decisions. In this mode, sets and subsets are identified in natural language and do not follow the rules of an elaborate conceptual grammar. Researchers of teacher cognition are currently looking for a declarative language adapted to didactic and pedagogical processes. The most advanced research, however, has had difficulty describing the mobility of conceptual strategies in teaching, and of creating a grammar based on rigorous descriptive elements, yet flexible enough to account for the cognitive and metacognitive levels which are translated simultaneously into a conceptual space and time. I will attempt to answer these questions throughout this article.

## A metasemantic representation of didactics

As a preliminary hypothesis, I propose to define didactics as the organization of meaning taught distinct from the interactive phase which I call pedagogy (Tochon, 1989b). In doing so, my ideas are closely linked to research on teacher planning which distinguishes preaction and postaction (didactics) from interaction (pedagogy), and to the concept of the double teaching agenda (Leinhardt, 1986). Didactic representation is a hierarchical anticipation of meaning which has yet to be transmitted, and is as such separated from the focal point of teaching-learning of pedagogical synchrony in the classroom. In other words, my analysis leads me to view the organization of meaning or of content as an object which differs from the immediate experience of teaching itself. Pedagogical representational features differ from those of didactics because of their particularly dynamic pragmatic dimension.

Representation is a construct used in social and clinical psychology as well as in the cognitive sciences. In theories of information processing, semantic representation consists of models of internal cognitive structures used to illustrate the conceptual

meaning associated with language, perception and thought. Representation theorists aim at developing a model which links comprehension and production in everyday language with perception, memory and reasoning (Anderson, 1982; Ericsson & Simon, 1984; Frederiksen & Breuleux, 1989). Their research focuses mainly on two levels: semantic networks based on generative rules, and structures of meaning stored in memory in the form of mental models or conceptual frames. This body of research tends at present to free itself from the static concept of schema which did not sufficiently explain the dynamic flexibility of connections between conceptual nodes (Holland, Holyoak, Nisbett & Thagard, 1986).

A semantic network is a data structure which includes nodes and the links between these nodes. Simple nodes refer to lexical concepts, whether they be primitive or identifiers of propositions. Complex nodes can be explicitly decomposed into other networks of nodes (Dansereau, 1989). Links or connectors specify the sort of relationship between nodes. Theories of semantic representation encompass several levels of analyses. The highest current level generates conceptual frames which determine meta-relations (metaframing) between networks containing other networks of semantic relations. This brings us back to our subject since didactics can be considered as the transposition of "scholarly knowledge" (Chevallard, 1985) as well as the generation of frames, conceptual links and links between networks capable of modifying long-term memory. "The existence of frame-level knowledge representations and processes associated with them implies that the description of an individual's performance in a semantically-complex task is likely to involve frame knowledge and processes associated with generating or manipulating frames" (Frederiksen & Breuleux, 1989, p.13). Consequently, didactic knowledge of subject matters can be described in terms of organization and of connections between representation frames.

In short, I will here define didactic metaframing as a representation of representations, that is as a set of rules based on core-organizers and connectors which form semantic metastructures, each one resulting from the embedding of semantic networks in other similar networks. In other words, didactics is capable of connecting semantic networks (propositional structures) to other networks so that meaning (propositional metastructures) may be transmitted. This process follows a set of metarules which I would like to describe, and which probably form the constants of experienced teachers' thinking.

Didactics are usually defined independently of their pragmatic configurations. Pedagogy, unlike didactics, deals with the interaction itself rather than with the representation of the past or future interaction in terms of contents. Therefore, the "performative" or pragmatic dimension in didactics would be static or declarative, while pedagogical dynamics would proceduralize didactic metaframes. In the words of Apotheloz (1983), external functioning is only partial in didactic discourse. That is one possible reason why usual didactic models and instructional designs seem so far removed from classroom action: they do not involve neither the teacher's ways of knowing nor his or her underlying intentionality. I therefore propose to model didactics we could call focal strategic didactics, taking into account pragmatic organizers as a descriptive tool of teachers' cognitive epistemology. Metaframing analysis is thus defined in this article as the recognition of clusters of propositions and didactic metapropositions in a specific pragmatic organization. The study of didactic representation is confined to a frame or a type of frame, and it involves a particular kind of epistemology. The scope of my research is the teaching of Language Arts at Junior high. According to many teachers, this junior high level follows constants which differ from those at other levels of education and from other subject matters. Furthermore, this framework is reinforced by the institutional structure to which my target group belongs. Didactic representation frames activated by this generic frame should therefore be relatively homogeneous. This

kind of frame creates other frames characteristic of a particular didactic action, in this case the design of Language Arts. Studying the didactic metanetworks of experienced teachers should help me identify the processes of meaning generation, that is the pragmatic organizers and connectors which link networks of thought-out meaning characteristic of a particular type of teaching (Shulman 1987 and 1988).

## 1. FRAMEWORK OF THE RESEARCH

The purpose of this research was to study the epistemic networks employed by expert teachers when processing the curriculum. Some examples of the questions addressed are:

1) What metaframing organizers and connectors are used by experienced Language Arts teachers, as revealed in the verbalization of their didactic thoughts during a semi-structured interview associated with the processing of the Language Arts curriculum?

2) How does experienced language teachers' thinking translate itself in terms of:

   a) organization and hierarchy of information;

   b) use of the curriculum for planning;

   c) subject matter knowledge and didactic transposition;

   d) expertise (routines and improvization) and knowledge transformation.

3) What are the characteristics and rules of the metaframing studied?

4) What are the relationships between domains of tasks in terms of conceptual organization and metacomponents?

The research presented here is essentially descriptive. It purports to describe the complexity of intricate and closely interconnected phenomena, in order to extract their variables by subjecting them to coding and by verifying their recurrences. The rules of taxonomic hierarchy, denomination, inductive assignment and deductive anchorage

followed will be presented in terms of coding criteria as well as through a homogenous body of definitions. The codes and definitions used are the result of a pre-inquiry whereby the degree of their adequacy to the corpus was established. Their theoretical relevance was verified by refering to literature and to everyday experiences in the teaching profession. The list of codes as well as their definitions appear in sections 3.2.4 and 3.2.5, and concrete examples for each metaconstituant are provided in this article.

A pre-inquiry phase was necessary to establish a first set of descriptive variables or codes. Through extensive reading and peer coding, the method of coding was refined. Several readings of the inquiry transcripts allowed me to further understand constants, and to identify several types of didactic organizers and connectors with precision. The list and definition of codes were refined a second time, and, consequently, more reading and coding was necessary. This method of recurrent analysis is recommended by several authors including Miles & Huberman (1984).

The coding of the transcripts revealed two levels of metaframing. Thanks to a conceptual grammar, the metaframes of qualitative thematic analysis were refined, with each node of a network being able to divide itself into just as many networks. It was discovered that didactic metaframing follows the embedding rules of a syntax upon which my research has shed some light.

## 2. METHODOLOGY

### 2.1 GROUP STUDIED

The role of experts in the definition of a subject matter is acknowledged by cognitive research, and their competence can be used to study, improve or create didactic

models. In order to study expert teachers' thinking in didactic processing, a sample group of experts who teach Language Arts at the junior high school level in Geneva was selected.

The problems encountered in the process of defining a group of experts were presented in a previous publication (Tochon, 1990a). By comparing operational definitions used in fifteen studies, I realized that the criteria used for selecting expert teachers not only vary from one study to the next, but also refer to very different epistemologies. Some researchers select correlational criteria characteristic of the process-product paradigm when studying teacher thinking, some follow the recommendations of peers or superiors, while others refer to their scientific and/or pedagogical training. Once the advantages and disadvantages of each procedure had been identified, a set of composite criteria for selecting expert teachers was established. 30 expert Language Arts teachers were selected by using the following procedure:

1) I first contacted eight institutional experts, that is resource persons whose competence is recognized by the administration of the junior high schools of Geneva. In this case, the people selected either were or had been officially in charge of the branch of learning or were methodologists who had come to know the 450 language teachers of their schools by training them or supervizing them in committees. I explained the purpose of my research in detail to each resource person, and asked them to recommend 5 to 10 teachers whom they considered to be the most experienced ones at the junior high school level. I then asked these resource persons to indicate and identify on a form their criteria of selection for each teacher.

2) In doing so, I obtained a list of 42 subjects to whom I then applied the following "filters":

a) Academic education: M.A. with a major in contemporary French;

b) Professional education: High school Educational Studies Certificate;

c) A minimum of 7 years of teaching experience (see Berliner, 1987).

After having done this, 4 subjects were eliminated.

3) Finally a criterion of random selection was applied to the remaining 38 subjects in order to lower their number to 30.

The research was approved by the board of school directors. A subsequent analysis of the group revealed that eleven of the seventeen colleges of the target administration are represented in my research.

## 2.2 RESEARCH INSTRUMENTS

The instruments developed for the research consisted of a semi-directed questionnaire and a simulation protocol. The questionnaire operationalizes questions raised in previous research done on expertise, planning and subject matter knowledge in the paradigm of teacher thinking. There are 24 questions in all, each one related to a topic of the literature reviewed. In conformity with this type of research, questions were asked only insofar as the teacher did not answer them spontaneously. For example during a 45 minute session, in his answer to the first question, one teacher answered many other questions without being asked to do so. The questions dealt with specific events in the classroom or current duties (Ericsson & Simon, 1984). The simulation protocol was developed after the pre-inquiry phase in order to justify the distinction between subject-matter knowledge and didactic competence and to allow teachers to better tackle the content of courses. This type of protocol is quite often used in research (Hashweh, 1987, Clark & Yinger, 1987). See section 2.4.2. for a detailed description of these instruments.

## 2.3 PRE-INQUIRY

The pre-inquiry was conducted during the 1987-88 academic year with five teachers who have considerable professional experience. These five teachers had obtained their teaching degree, and had been hired to teach language courses. They all taught at the same college, and were well respected by their colleagues. Each one represented a particular teacher model, and had didactic conceptions which were quite different from one another. They each saw their classes from 6 to 7 hours per week. I chose these subjects for I knew their teaching experience well, and was thus able to analyze more in depth their didactic processing. This phase of the research consisted of semi-directed interviews lasting from three to eight hours with each teacher. The following year, four of these pre-inquiry subjects were on the list of experts, having been recommended by several resource-persons (see the procedure described in section 2.1).

The purpose of the pre-inquiry protocol was to expose guidelines and habits of planning as well as the connotations of the term "planning" for each subject. The instrument dealt with the following themes of research: applied theories, didactic modeling adaptation of plans, routines and improvization. It deals with these themes so as to check their relevance and adequacy to the population studied.

## 2.4. INQUIRY

### 2.4.1 Interviews

Most of the inquiry was conducted at the beginning of the school year during the months of September to December. The teachers received a letter inviting them to participate in the project, and then were contacted by telephone. Two of them declined to participate in the project and were replaced by two other subjects chosen on a

random basis. The reasons given for withdrawing from the project were the following: one teacher refused to be interviewed because she wanted to spend more time with her child and had a heavy work load. Another teacher was opposed to any form of university interference in his field of teaching, stating that the risk was too great of having inadequate models of teaching imposed upon him after a non-practician research. As for the other teachers, they were more than willing to comply with the methods of this research. During the interview, I wrote down the main ideas of their answers on a form while at the same time recording the entire interview.

### 2.4.2. Simulation

The inquiry focused on concrete examples of the didactic processing of four objectives and of the junior high school curriculum in Geneva belonging to different taxonomical levels. These four objectives were chosen so as to distinguish between the level of knowledge complexity (weak/strong) and the level of didactic elaboration (weak/strong), as shown in figure 1. No indication of the level of difficulty was given on the form handed out to the teacher for the purposes of the simulation. Given the possibility of embedding these four objectives, it was therefore possible to study questions pertaining to methodological convergence while analyzing didactic processing.

**Text used for the simulation protocol**

Could you explain to me in detail how you would proceed with the following four objectives for a grade 8 Language Arts class? This will enable us to discuss some concrete examples. How do you prepare yourself? Take all the time you feel necessary. The most important thing is not to develop the perfect plan, but rather to indicate how you view your teaching routines, the way you taught last year, and the way you will teach tomorrow or next week. Explain what guides you in processing subject-matter knowledge, and give me narratives of your experience in the classroom concerning

these four objectives.

CODING OF THE SIMULATION PROCEDURE

| Level of knowledge complexity | Level of didactic conceptualization: low | Level of didactic conceptualization: high |
|---|---|---|
| low | 1. Put commas in the right places when punctuating a text | 2. Conduct an inquiry for a report |
| high | 3. Develop and explore a lexical then a semantic field | 4. Analyze the structure and the dynamic relationship between the characters of a story |

Figure 1

## 3. PROCEDURE OF ANALYSIS

### 3.1 ANALYSIS OF THE PRE-INQUIRY

#### 3.1.1. Thematic networks

First of all, the interviews, typed out verbatim, were coded in the margins. For example, each time an adaptation or routine was mentioned, I wrote A or R in the margin, and underlined the passage pertaining to it. All underlined passages were then transfered

onto cards. There were three advantages to processing information in this manner: 1) comparing cards with elements of the corpus was a way of facilitating the analyses; 2) computers were brought into the picture and 3) once the cards were arranged in columns characteristic of conceptual networks, quantifying became possible, and synthesis was easier. However, a great deal of effort was required to do this.

**Results**

The results of the pre-inquiry will be briefly discussed here since they were taken into account in the methodology of the inquiry itself. The interviews of these five language teachers shed some light on the major difficulties of didactic processing. Of the 456 comments pertaining to didactic processing, 127 comments (27.4%) dealt with problems specific to planning for language classes. Furthermore, it appears that the results were identical to those of the studies conducted by Robert Yinger and Christopher Clark. The specific constants of teachers' thinking when organizing their subject-matter knowledge, whether in Geneva or in Michigan, are as follows:

1) Didactic processing presents many problems and theories turn out to be of little help in solving these problems;

2) Linear models of processing are incompatible with relationships between teachers and students;

3) Processing is continuously being adjusted by teachers who must constantly adapt to classroom situations;

4) Teachers use different strategies at the same time depending on the time limit or the subject;

5) After implementing and evaluating a plan, teachers tend to transform it into a routine plan if the strategy proves to be successful;

6) With the help of routines forming a preliminary frame, the expert can improvize, that is go back to and from his cognitive networks and his relationships with students.

The results of the pre-inquiry, imply (Tochon, 1989a) the following conclusions:

1) While rational methods of training seem partly suitable for novices, they do not correspond with experienced teachers' practices.

2) Linear representations of teaching do not correspond with actual practices because interaction with students requires an adaptative mobility. This means that it is possible at any time to branch out, change one's initial goals, and reverse, develop and shorten objectives or notions.

3) The degree of competence in teaching appears to be proportionate to a teacher's ability to rapidly adapt his or her teaching to students' needs, as well as to everyday classroom experiences. This is made possible by internalizing didactic macroframes proven by experience to be successful.

4) Didactic models which impose an exclusive perspective neglect the fact that some strategies turn out to be successful in some contexts, disastrous in others, well adapted for a particular period of the week or only for a certain period of the year, or for some students and not for others.

5) Gradual embedding throughout the years of experiential frames which fit together allows the teacher to give more attention to his or her students. No current theoretical model can explain the complexity of political considerations that an expert teacher spontaneously selects and processes. Their way of knowing is still unknown.

6) Routines, that is the embedding of several interconnected frames, are a requirement of the profession. This has to be taken into account in any innovation since access to new approaches can only be made possible by linking them to previous approaches.

### 3.1.2 Epistemic networks

During the pre-inquiry, I noticed that teachers used metaphors to express themselves. Lee Shulman (1986 and 1987) had just postulated the hypothesis that knowledge required to transmit knowledge was expressed in images of everyday life, providing

good examples and informative anecdotes. I therefore decided to find nodular metaphors whose multiple links created real epistemic networks in the corpus of the pre-inquiry. These networks are characteristic of a subjects' epistemology (Tochon, 1990b). In order to find the nodular metaphors, I used the well-known technique of concept-mapping. However, I used a variant which is seldom used in research: Tony Buzan's (1974) method. This method, used mainly for taking notes and memorizing syntheses, requires images or drawings to represent the key elements of discourse. Using non mediatized images from the text appeared to be the best way to describe metaphorical or epistemic networks. The technique consisted of choosing the keywords of a discourse, and linking them with lines going from the center to the perimeter. Metaphorical nodes were then represented by drawings. A concept graph was drawn up for each of the five teachers.

**Results**

Results are currently being analyzed (Tochon, 1990b). In short, metaphor-mapping exposes epistemological structures which underlie choices made by teachers. One of these dynamic structures of meaning consists of co-existing opposites which link together the epistemic field. Metaphors in teaching practice have polar and dyadic structures. The teacher is constantly caught between theory and practice, organization and creativity, firmness and flexibility, performance and listening, intellect and affectivity, technical and human factors. Thus, a series of problematic binarities associated with didactic processing were brought to light.

Some terms seemed to have been expressed in a non-binary way, and presented a compromise between a set of epistemological dualities. These terms unite a series of opposites, and shed light on what I would call educational pragmatics. A first series of terms expresses teleological or goal-directed processing: progress, direction, goals. Each teacher who was interviewed used these words. Other terms of a synthetic nature

referred to regulation in the classroom situation: feedback, adapting to emotions, flexibility depending upon the context.

The following are the conclusions of two aspects of the pre-inquiry's analysis thematic and epistemic networks, that played an influential role throughout the entire inquiry:

1) Didactic processing is determined by function (in other words, metaframing is determined by focal interaction);

2) Didactic processing includes high and low periods, that is to say a rythm or alternating and linking principle between domains of tasks;

3) Didactic processing develops a pragmatic strategy which focuses entirely on certain key themes, linking domains of tasks and/or levels characteristic of a domain of tasks: Less significant themes are linked to more central ones;

4) Processing remains a frame, projecting certain stages on to the next stage. This corresponds to an adaptive progression;

5) Didactic metaframes are developed organically in correspondance with the context.

## Discussion

In studying the metaphor, I was drawn to the works of Munby (1897), Russell (1987a and b), as well as to those of Tobin (1989) who observed that the teacher models his or her knowledge in a metaphor that he or she can identify with, and which conditions his or her didactic organization and certain pedagogical acts. Tobin notes that a teacher will change his or her organizing and behavior if his or her metaphor is changed. In other words, according to Tobin, didactic processing and behavior are mainly determined by very general representation frames which have been developed in the form of metaphors. Quite obviously, the second part of the analysis of my pre-inquiry shed some light on the epistemological networks and on the metaframes which

condition the organization of the transmission of meaning and, therefore, didactics. However, I was not satisfied with these results insofar as I was looking for components which would be less diffused than Ochanine's operational images (1978) or Tobin's metaphors (1989) and clearly show cognitive and meta-cognitive rules specific to the elaboration of mental didactic models. By rereading the results of the pre-inquiry, I realized that the two series of pragmatic terms of planning which I had at first believed were synthetic, formed in fact a polar dyad. At a higher level, the teleological axis of the first series (progress, direction, goals) was the opposite of the disorganizing nature of the adaptation axis (feedback, flexibility depending upon the context...). I concluded that there are didactic organizers and disorganizers whose functions differ, and whose concrete actualization had to be studied in the simulation protocol. Further reading of the inquiry's corpus quickly confirmed the existence of this polar metaframe, of which frequent and explicit examples were found in the interviews.

## 3.2 ANALYSIS OF THE INQUIRY

The pre-inquiry confirmed the relevance of the inquiry's subject as well as the vast supply of information that one can gather from teachers' thoughts. My disatisfaction with the methodology can be explained by the newness of this type of research and by my earnest desire to discover in didactic epistemology operational laws which could be represented in a model. In order to strengthen my approach, I looked into qualitative analysis software programs. Quite obviously, everything depends on how one uses them. Heuristics biases can be found at all levels of research analysis (Tversky & Kahneman, 1974). The aspect of previous analyses which I found particularly disappointing was their thematic dimension which only allowed me to rediscover what others had already discussed. I was looking for some rules of didactic meaning making and a method to test them. I therefore needed to develop analytical tools adapted to my corpus.

I examined the possibility of using cognitive framing methods to study didactic metarepresentations. Cognitive semanticians study textual organizers and connectors in simple texts, some of which are verbalized subject-matter knowledge of a student or an expert. I was interested in didactics, the metatext in teacher thinking. In order to do this, the validity of the following method has been established: one has to define the scope of domains of tasks as well as to identify their semantic organizers and connectors. Since Language Arts didactics is an embedding of texts in other texts, I decided to apply to didactic metaframes the analytical procedures which, up until then, had been limited to studying simple frames taken out of context.

Domains of tasks or organization of meaning still needed to be defined. A first reading of the inquiry corpus, during which I attempted to isolate organizers of meaning for the Language Arts by using the generic code R, revealed that domains of tasks identified by descriptive and prescriptive literature have a certain relevance, and are even remarkably homogeneous.

These domains are networks of organizational nodes defined within the limits of the curriculum. Vertical and horizontal links exist between domains of task organization, thus confirming what had been propounded by research literature. I transformed these organizational domains into just as many codes in order to study their characteristic processing by identifying them systematically in the corpus.

### 3.2.1. Horizontal didactic processing and domains of tasks

**Theory**: Literature dealing with language classes is based on the co-existence of four skills: oral reception (listening), written reception (reading), oral production and written production (Vallette & Disick, 1972). This distinction, especially in second languages, was confirmed by many authors to the extent that the language curricula quite often

adopted it. Thus, it implies a form of didactical metaframing well known to teachers. Gilles Gagné (1987) has demonstrated its mode of functioning for language teaching. Through a meta-analysis, he developed a model of tested and hypothetical correlations between linguistic components, sheding light on the developmental interrelationship of these domains in didactic organizing.

**Practice:** Language Arts teaching requires that domains of tasks be defined. The teacher sees his or her students between 5 to 7 hours a week, and he or she tends to divide the domains of tasks in such a manner that students will know how to get organized, and will bring the necessary material to class. The method of dividing domains of the administration studied usually consists of alloting one hour to oral exercises (reception/ mixed production), two hours to continuous reading (novel, etc.) alternating with two hours of composition, two hours to language techniques, spelling and grammar (work upon the code), and perhaps one hour to reading discussions of short texts. While the vast majority of experts free themselves from this limited structure used by other teachers, they manage to retain flexible domains of tasks which are developed in parallel and, therefore in a horizontal relationship.

In short, both from a practical and from a theoretical point of view, it appears that basic skills or domains of tasks of language teaching possess horizontal connections. Horizontal connections has therefore been retained as an element for coding.

### 3.2.2. Vertical didactic organization

**Theory:** Current theories of representation reveal the existence of an embedding of several levels of meaning, ranging from linguistic structures to conceptual frames, and including propositional relationships. This set of theories also sustains the existence of a vertical axis of conceptual connections (Chomsky, 1981).

-Cognitive analysis of planning in writing reveals the existence of a vertical axis in the perception of text elaboration. At one end of the axis there are letters and sounds and at the other end with ideas and goals. Expression and conceptual development are located at the median point of the axis (Scardamalia & Bereiter, 1986, pp.782). Writing experts have control structures which allow them to pass from one level of framing to another rather effortlessly. This confirms the importance of vertical connections between levels in the cognitive planning of experts (Beaugrande, 1984).

-Cognitive analysis of planning in reading also brings out vertical types of inclusive relationships. Focus in reading is constantly being compared with a prototype of textual comprehension (Calfee & Drums, 1986), and decoding is processed through vertical connections between several levels of conceptual connections which fit together.

-Other types of vertical connections could be mentioned in other sectors of the cognitive sciences (relationships between schema and script or between short, medium and long term memory). However, there are a sufficient number of arguments to justify coding the elements which illustrate the vertical connections between levels of embedded cognitive tasks.

**Practice**: Seeing that the curriculum is overloaded, teachers report that they must embed several levels of didactic knowledge by creating conceptual connections whenever possible. This means there are vertical connections between practical domains of tasks. This aspect comes out quite clearly in the corpus of the inquiry. In short, both from a theoretical and from a practical point of view, it appears justifiable to assume vertical types of conceptual relationships exist, and that they can be isolated by means of a specific coding.

### 3.2.3. Levels of didactic processing

**Theory of learning:** There is currently a relative consensus about the identification of three levels of knowledge involved in metacognitive processing (Paris, Lipson & Wixson, 1983; Schoenfeld, 1985; Jones et al., 1987; Marzano et al., 1988). Metacognitive control is based on activating declarative knowledge by using procedural and conditional knowledge.

-Declarative knowledge deals with factual data, and answers the question "What?";
-Procedural knowledge deals with the necessary steps to accomplish a task, and answers the question "How?";
-Conditional knowledge deals with the conditions for applying knowledge, and answers the questions "Why?" and "When?";

**Theory of teaching:** I reviewed the work of a dozen authors who had elaborated unified taxonomies. These taxonomies involve three levels of didactic knowledge which are surprisingly homogeneous:

-The first level deals with the contents of the subject matter;
-The second level deals with the processing of these contents and it is interdisciplinary;
-The third level deals with self-regulated and context situated transdisciplinary actions.

Details of the comparison of these taxonomies appeared in Tochon (1989c). Its theoretical use was subsequently developed in Tochon (1990c). Pragmatic, deductive and inductive approaches of different authors all corroborate these three levels, which lead me to accept this trinity as a valid didactic metaframe. This structure corresponds surprisingly with the three levels of cognitive psychology. Furthermore, while reading the corpus of the inquiry, I noticed that this distinction seemed to be operational. For these reasons, I decided to identify in the corpus of the interviews the parts pertaining to these three levels of organization. Related codes are clearly defined below.

### 3.2.4 Metaframe indicators

Connector Code: C

A connector establishes a conceptual and pragmatic link between organizers, metaconcepts or domains of metaframing.

Example: *"During the second period, oral expression will be linked with a inquiry."*
Rca (ORAL) C (Rco (inquiry))

Organizer Code: R

A didactic organizer is a pragmatic mold shaping one or more metaconcepts, a curricular task domain, or even an entire metaframe. It is intrinscally part of an epistemological network. It also determines the content processing mode and the didactic intentionality. It potentially includes the dynamics of the focal experience of teaching itself.

Examples: Below, various types.

Metaconcepts

A metaconcept is a conceptual node pertaining to one of the task domains of the curriculum. It is also as a metapropositional unit in propositional analysis and epistemological network.

Example: inquiry, above.

### 3.2.5. Metacomponents

Metacomponents were determined by repeated readings of the corpus and further consultation of the research literature. The metasemantic and pragmatic grammar presented in this article is new, even though its infrastructure conforms to that of semantic grammars currently being used (Frederiksen, 1975; Preece, 1978). The examples given below follow regular bracketing rules. However for the sake of

information processing, an abbreviated grammar was adopted, in which each proposition presents a connection between two single domains of tasks through one organizer. Examples of these abbreviated conceptual metapropositions are given at the end of the article.

Vertical connector Code: VC

A vertical connector establishes a conceptual link between two or more levels of framing; it determines the relationship of embedment, for example in the subordination axis of certain concept maps.

Note: When conducting a propositional analysis of long embedment chains, it is possible to omit the vertical connector since the embedding is already indicated by parentheses. However, it will be shown below in order to illustrate the method followed.

Examples: *"Reading a text out loud with no punctuation is also a way of teaching students that punctuation is necessary in order to understand a sentence."*
RS (Rco (ORAL (VC (Rca (READING (VC (Rca (technique))))))) =
RS (Rca (TECHNIQUE (VC (Rna (MEANING)))))

*"I view the concept of technique as a tool used for doing work."*
Rco (WORK (VC (Rca (TECHNIQUE))))

*"She starts writing her summary in the third person, and as she continues to write, she will all of a sudden identify with the narrator, and say "I" because she has become engrossed by the book she is reading."*
Rca (WRITING LC (Rna (READING))) VC (Rca (TECHNIQUE (VC (Rca (PERSON))))) =
Rca (READING (VC (Rna (narrator))) LC (WRITING (VC (Rca (technique (VC (Rca (person)))))))

Lateral connector Code: LC

A lateral connector establishes a conceptual link between two domains. It often transfers the same organizer from one domain of tasks to another.

Examples: *"On the basis of summaries which the students had to do as part of their continuous reading, I will show them the strong points as well as the weaknesses of a summary of which they will have been given a photocopy."*
Rna (READING LC WRITING VC (Rca (summary))) LC ORAL (VC (Rca (summary (VC (Rca (attributes))))))

*"I choose a theme and work on expression, then reading, and then writing."*
Rna (theme (VC (Rca (ORAL LC READING LC WRITING))))

Alternation connector Code: AC

An alternation connector establishes a conceptual relationship of alternation in time between two or more domains, that is a relationship which is repeated rather than simultaneous, whether it be horizontal or vertical or alternatively horizontal and vertical. Quite often, it is related to alternating action within a metaframe (ORAL/WRITING, expression/code, WRITING/READ- ING...).

Examples: *"Once again, I will give them their copy, and, for homework, they'll have to..."*
AC (Rca (READING LC WRITING) VC (Rca (homework)))

*"Summarizing is a kind of exercise that will be repeated more than once. Later on, it will be possible to refer students to this type of descriptive card of a summary."*
AC (Rca (summary)) AC (Rca (card))

*"The schema (of a lesson) is quite often the same."*
AC (Rca (schema))

Narrative organizer or "narrativor" Code: Rna

A narrativor is a didactic narrative organizer; it is intended to develop students' declarative knowledge (therefore, content) in the form of themes, images, anecdotes or stories.

Examples: *"I will see whether I begin with poetry or stories."*
Rna (poetry/stories)

*"Once again, we tackled the slightly stereotyped image of the terrifying and sinister haunted house, but, at the same time, it was very funny."*
AC (Rna (props (VC (Rco (emotions)))))

*"A short exercise of describing images in detail, and which actually allows a person to describe as well as to present oneself."*
Rca (ORAL (VC (Rna (description (VC (Rca (image)) LC (Rna (oneself)))))))

Note: Narratives of experiences (Connelly & Clandinin, 1988), which appear frequently in the corpus, are abbreviated Rna (X (VC (Rco (Y)))) insofar as they draw a student close to an actual experience or a personal feeling; however, an actualizer at level one clearly has more experiential power than when it is embedded in a narrativor at level two.

Instrumental organizer or "skiller" Code:Rca

A skiller is a didactic instrumental organizer; it is intended to develop procedural knowledge which focuses on a skill, an operation or a procedure forming a component of an action.

Note: An organizer can be a skiller of a skiller situated at a higher level. It is also possible to omit a skiller at a lower level in order to simplify abbreviations, something I did not do here for the purposes of the demonstration.

Examples: *"I spent half of the year doing exercises on deconditioning and unblocking."*
AC (Rco (ACTION (VC (Rca (deconditioning (VC (Rca (exercises))))))))

*"Thus, write down directions on a piece of paper which will be a sort of reference document valid for all the summaries to be done during the year."*
AC (WRITING (VC (Rca (summary (VC (Rca (directions)))))))

*"Afterwards, when they expressed themselves orally, they knew they did not have the right to start a sentence without finishing it or to give their opinion without justifying it."*
RT (ORAL (VC (production (VC (Rca (complete sentences) LC (justification))))))

*"I would waste a lot of time explaining to them how to do their work. Something as silly as how to organize a loose-leaf binder, and I would be very strict. The table of contents is written every time they receive a new paper".*
Rca (WORK) VC (Rna (ORAL (VC (Rca (directions))))) =
Rca (binder) VC (Rna (WRITING (VC (Rca (table)))))

Experiential organizer or "actualizer" Code: Rco

An actualizer is a didactic experiential organizer; it is intendend to develop contextual knowledge by focusing teaching on actions, on the relationship with concrete and everyday experiences.

Note: Actualizers at level one are always linked with an action. Consequently, the argument ACTION can be omitted from the series. I did not do so in this article for the purposes of the demonstration.

Examples: *"I like to use something concrete as a starting point, that is a reality closely related to the students' own experiences."* RS = Rco (ACTION (VC (R (curriculum))))

*"We will shoot a film together, and, then, using that as a starting point, I will organize the rest."*
Rco (ACTION (VC (Rca (film) VC (R (undetermined) LC (undetermined)))))

*"To tackle fairly large projects with the students in order to arrive at something concrete."*
RS = Rco (ACTION (VC (RT (undetermined))))

*"The students questioned people on the street."*
Rco (ACTION (VC (Rca (ORAL (VC (Rca (interviews)))))))

*"Most of the students did it as though it were something personal."*
Rco (ACTION (VC (Rca (belonging))))

*"Quite often, I call on their everyday experiences or try to put them in situations close to their everyday life."*
AC (RS = Rco (ACTION (VC (Rca (situations (VC (Rca (belonging)))))))))

Process organizer Code: RS

A process organizer markes the starting point of a phase of discovering knowledge. It focuses on the beginning of the process rather than on the product. Process organizers can be developed in a narrative form, in an instrumental form or in an experiential form.

Note: The notation RS = Rco can be abbreviated RSco; similarly, RS(Rco(x)) can be rewritten as RSco(x) with the same possibility for RSca or RSna. I did not take into account the possibility of these abbreviations in this article.

Examples: *"We'll study a number of texts similar to a summary in order to learn why they are presented in one way or another and what they correspond to, etc."*
RS (READING (VC (Rca (summary (VC (Rca (texts (VC (Rna (attributes)))))))))))

*"Questions were asked very quickly. And suddenly, the discussion took off in all directions..."* RS (Rca (questions (VC (Rca (ORAL (VC (-R (undetermined)))))))))

*"To arrive in class with an object to start off an activity with the students, stop to check if it's ok, what's effective and what isn't."*
RS (Rca (support (VC (RT (Rco (ACTION) CL (metacognition)) LC (Rca (attributes))))))

Organizer of products Code: RT

With a product organizer, didactic organization focuses on the product, rather than on the process itself. The shape of a product organizer can be narrative, instrumental or experiential.

Note: Comments related to the symbols used are identical to those made about the process organizer: RT(Rco(x))=RTco, same for RTca and RTna.

Examples: *"This allows me shape the lesson in such a way that the students won't be surprized when it is time to work."* RT (control (VC (RS (lesson))))

*"In order to end up with something concrete."* RT (determined)

*"We simulated these situations orally to try and see how we could have developed something, what else we could have said, and, finally, we ended up developing a questionnaire."*
Rco (ACTION (VC (Rca (ORAL (VC (Rca (expression))))))) VC (RT (improvement) LC RT (WRITING (VC (Rca (questionnaire)))))) LC ORAL)

*"On the one hand, students know why they are doing this exercise, and, on the other hand, it is an exercise which is less artificial than saying: "Now we're going to study this particular field in itself."*
RT = (Rco (metacognition)) LC (Rca (field) # RS)

Disorganizer Code: -R

The disorganizer is an element of didactic metaframing characterized by the absence of a subsequent connection. Its connection with domains of tasks or levels of organization must be created by the learner. The disorganizer is a "problem formulator", and causes metaframes to be suspended. In the words of Beaugrande (1984), it is an element from which reaching the next element is neither guaranteed nor required. It creates an optimum space for learning (Vygotski, 1938). It represents the "zero limit point" of didactic function, where didactics enters the interrelational field.

Examples:

*"The element of surprise, for example. I like relying on the effect of surprise to keep the students on their toes."*
-R (surprise (VC (Rco (undetermined))))

*"There were coordination problems, they had to act and solve them by themselves."*
-R (Rca (coordination)) = RS (Rco (ACTION))

*"And then if another support is found, the student must be capable of making sense of the work. It's part of the game. No information is given. He or she must know what work to review and what notions he or she will need to know in order to succeed."*
-R (support) = RT (Rca (work) VC (Rca (review) VC (Rca (needs))))

*"Quite often, I used a method which consisted of giving them an activity to do without much preparation. At one point, they notice that it doesn't work. Why not? We analyze the situation and, in this manner, I draw their attention to the need for preparation."*
-R (Rco (ACTION)) = RS (undetermined ) LC (RT (ORAL (VC (Rca (analysis))))) = RT (Rca (planning))

*"The discussion took off in all directions, but I let that go, and then suddenly, there was opposition and strong disagreement amongst them. They had to decide for themselves."*
Rca (ORAL (VC (-R (undetermined)))) = RS (Rco (ACTION (VC (Rca (DECIDING))))))

## Additionnal explanations

All the interviews were printed with a 2 inch margin on the left for coding. Codes were also used during the second phase of coding with the software program. In order to

name the organizer or the connector being analyzed in the corpus, I called upon two procedures known as anchorage and assignment. When the teacher interviewed gave a name to his or her mode of doing, and explained what it was, I put the terms of his or her definition in a class of equivalences. However, when the name was absent but the object of discourse was homogeneous, I placed the mode of organization or connection in a class and gave it the name of a category. The definition of categories is thus the result of interaction between anchorage and assignment.

### 3.2.6. Phases of analysis

a. Coding metastructural variables in the selected texts: 1) on paper; 2) on computer. This phase was carried out with the help of the software program. Since it was hard to develop rules for the predicative analysis of a corpus of some 3.4 million letters, they were simplified in order to allow computer coding and processing, taking into account the capacity of the software program (in order to permit quantification and comparison of frames directly from the computer program). In fact, rewriting rules (bracketing, for example) could be useful if the goal was to develop a didactic tutorial program based on metaframe analysis. However, this was not the goal of this inquiry nor of its modeling.

The simplified rules define the relationship between the domains of tasks and the modes of organization adopted by the teacher. Each complex computer code defines an entire proposition and shows the connection between two conceptual nodes. The relationship between a type of organizer of an original domain of tasks and a target-domain is defined either in terms of processes or in terms of product. The domains of tasks considered in this analysis are those of the curriculum: oral expression, writing, reading, language techniques and grammar. I also added an inter-domain code when the domain studied covered several domains of the curriculum. 450 codes were

obtained in this manner, 50 more pertaining to the disorganizers were added, thus giving a total of 500 virtual macropropositional sentences transformed into complex codes. Figure 3 illustrates the criteria for composing the complex computer codes or macropropositions, while figure 4 shows the computer entry for the text analyzed in figure 2.

b. Individual profiles and comparison of experts hâve been established from computerized variables by code patterns or sequences and by independant variables such as college membership, experience in teaching and gender.

c. Analysis of codes and their relationships. Concept mapping is used to support a demonstration when a more "clinical" analysis of a particular macroframe is necessary.

d. Establishing the rules and propositions of the metaframing being studied. Modeling metasemantic representations and analyzing processes involved in generating and manipulating didactic metastructures. This phase follows the rules which are currently being used in conceptual graphism and/or the notation of predicate and argument. An example of this is given in figures 2 and 5. It should eventually be possible to reproduce generic metaframes in the form of a conceptual graph.

## 4. CONCLUSION

The purpose of this article was to demonstrate the possibilities of conceptual and pragmatic analysis for identifying epistemological processing in teacher thinking. These "modes of organizing thought" condition classroom planning, they shape meaning from a virtual didactic knowledge-store and scaffold further pedagogical interactions. The semio-cognitive grammar I am proposing is adapted to the analysis of teachers'

verbalizations. The purpose of this metasemantic and pragmatic grammar is to analyze the procedures of didactic embedding. This grammar will probably prove to be useful in the analysis of didactic transposition in other subject matters. This modeling might lead to pedagogical applications. It could help bring about some understanding of the expert ways of didactic improvising in a pedagogical context and, why not, induce a new metacognitive and pragmatic instructional design.

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INSERT FIGURES 2,3,4,5

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# Figure 2

| | ANALYSIS: |
|---|---|
| "I worked mainly on vocabulary in order to enrich compositions and texts. (Anchorage) | WRITING(VC(RTca(vocabulary))) |
| For example, if it was a matter of working on props or portraits, I asked the students to forms groups and find a corpus of words which would correspond with a given point, and which could be used to form part of a portrait or a prop. (Anchorage) | 1.<br>Rna(props;portraits)<br>VC(Rco(group work))<br>VC(Rca(lexical field)) |
| For example, at the start of the year, we started with props. I asked the students to work on them. Also short oral exercises were done with little preparation. I noticed that the students gave visual descriptions of what they saw when they had to describe the props. For example I had them placed in practical situations such as working with sound effects cassettes. I made them aware the descriptive props not only affected us visually, but also through sound, smell, that is the five senses. | 2.<br>Rna(props)<br>AC(Rco(ORAL))<br>VC(Rna(images))<br>(anchorage)<br>LC(Rco(sounds)) |
| So afterwards, I gave them five stencils which illustrated the five senses. They had to prepare their composition by placing a certain number of elements related to each sense in a box. | 3.<br>RSna(props) = Rna(description)<br>VC(Rco(visual + auditive + olfactive + touch + 5 senses)<br>4.<br>RTca(stencil(VC(Rco(5 senses)))<br>RT(WRITING)<br>Rna(props(VC(Rco(5 senses)))) |

| PROPOS-ITIONS | PREDICATE | MACROFRAMES |
|---|---|---|
| TEXT | (STATE | (WRITING(VC(Rca(vocabulary)))=RTca(WRITING) = 1 + 2 = 3(RT4))) |
| 1 | (EVENT | (RSna(props;portrait(VC(Rco(work group (Rca(lexical choice))))))) |
| 2 | (EVENT | (RSna(props) CA (Rco(ORAL(VC(Rna(images) LC (Rco(sounds))))))) |
| 3 | (STATE | (RSna(props) = Rna(description(VC(Rco(5 senses)))))) |
| 4 | (EVENT | (RTca(stencil(VC(Rca(vocabulary(VC(Rco(5 senses))))))) = RTca(WRITING(VC(Rna(props(VC(Rca(vocabulary (VC(Rco(5 senses)))))))))) |

It is possible to present the notation "predicate-argument" shown above in the form of a conceptual graph (See figure.5).

**Figure 3**

Codes composition for computer processing

| REFERENCE | TARGET DOMAIN | CONNECTOR | ORGANIZER | STARTING DOMAIN | |
|---|---|---|---|---|---|
| S Processus | O ORAL | ( Vertical connector | na narrativer | O ORAL | |
| | L READING | | | L READING | |
| | E WRITING | - Lateral connector | ca skiller | E WRITING | |
| T Product | T Language techniques | | | T Language techniques | |
| | I INTER-DOMAINS | / Alternation connector | . co actualizer | I INTER-DOMAINS | - 450 codes |
| idem | idem | none | -R disorganizer | idem | - 50 codes |

EXAMPLE:

The code TE(caT means that language technique (grammar, verbs, spelling, vocabulary) is used as an instrumental organizer (ca = skiller) of which the product is to improve WRITING (TE).

The codes are therefore read upsidedown since the starting-domain is to the right, and the target-domain to the left. This notation allows hierarchy in terms of target-domains which generally have priority over others.

Second example: SE/coO refers to a concrete actualizer in oral expression linked alternatively with the processus of learning WRITING (SE).

## Figure 4

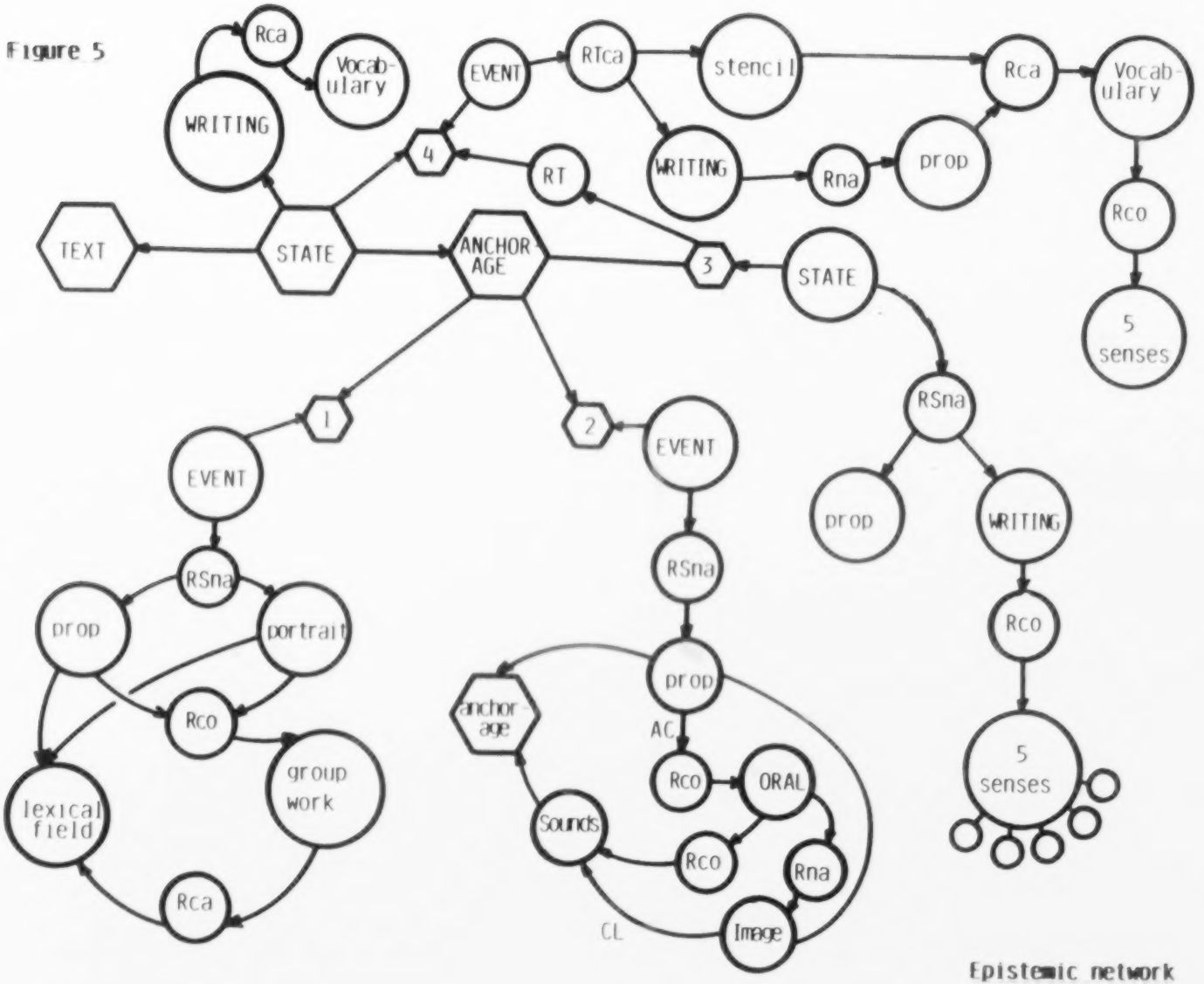
Entry of the codes on computer

```
    ┌ TE(caT                                  1: 1 ->    2: 7
  ┌ | TE(naE                                  1: 1 ->    4:65
  | |  1 "I worked mainly on vocabulary in order to enrich compositions and
  | └  2 texts.
  |    3
  | ┌ TE(coT                                  4: 1 ->    7:30
  └ |  4 For example, if it was a matter of working on props or portraits,  I
    |  5 asked the students to form groups, and find a corpus of words which
    |  6 would correspond with a given point, and which could be used to form
    └  7 part of a portrait or a prop.
       8
    ┌ SI(coO                                  9: 1 ->   11:24
    |  9 For example, at the start of the year, we started with props. I asked
  ┌ | TE-coO                                  10:30 ->   19:46
┌ | | SO(caO                                  10:31 ->   14:29
| | | 10 the students to work on them. Also short oral exercises were done
┌ | | SE/coO                                  11:25 ->   12:67
| | | 11 with little preparation. I noticed that the students gave visual
└ | |  12 descriptions of what they saw when they had to describe the props.
  | | ┌ SI/coO                                13: 1 ->   16:17
  | | |  13 For example, I had them placed in practical situations such as working
  └ | |  14 with sound effects cassettes. I made them aware the descriptive props
    | |  15 not only affected us visually, but also through sound, smell, that is
    | └  16 the five senses.
    |    17
    | ┌ TE(caT                                 18: 1 ->   20:50
    | |  18 So afterwards, I gave them five stencils which illustrated the five
    └ |  19 senses. They had to prepare their composition by placing a certain
      └  20 number of elements related to each sense in a box."
```

| | | |
|---|---|---|
| 1 | 1 | SE/COO |
| 2 | 1 | SI(COO |
| 3 | 1 | SI/COO |
| 4 | 1 | SO(CAO |
| 5 | 2 | TE(CAT |
| 6 | 1 | TE(COT |
| 7 | 1 | TE(NAE |
| 8 | 1 | TE-COO |

In total 8 different codes with in average 1.1 occurrences and a standard deviation of 0.35

Figure 5




Epistemic network

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